R E P O R T R E S U M E S

ED 020 106 SE 002 278

CONGRESS ON SCIENCE TEACHING AND ECONOMIC GROWTH.
INTER-UNION COMMISSION ON THE TEACHING OF SCIENCE

PUB DATE 65

EDRS PRICE MF-$0.25 HC-$2.20 53P.

DESCRIPTORS- *CONFERENCE REPORTS, *CURRICULUM, *INTERNATIONAL EDUCATION, *MATHEMATICS EDUCATION, *SCIENCE EDUCATION, *TECHNICAL EDUCATION, *TEACHER EDUCATION, BIOLOGY, DEVELOPING NATIONS, CHEMISTRY, GEOLOGY, MATHEMATICS, NATURAL RESOURCES, PHYSICS, SOCIOECONOMIC PROBLEMS, TECHNOLOGY, UNITED NATIONS ORGANIZATION FOR EDUCATION SCIENCE AND CULTURE, FORD FOUNDATION, INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS,

REPORTED ARE THE ACTIVITIES OF THE CONGRESS ORGANIZED BY THE INTER-UNION COMMISSION ON SCIENCE TEACHING (CEIS) OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS (ICSU). STUDIED WERE PROBLEMS ARISING IN SEVERAL BRANCHES OF KNOWLEDGE DUE TO BOTH INCREASED NUMBERS OF STUDENTS AND SHORTAGE OF TEACHERS. OF PARTICULAR INTEREST WERE THE PROBLEMS OF DEVELOPING NATIONS. REPRESENTED AMONG THE 84 PARTICIPANTS WERE NINE AFRICAN STATES, THE UNITED STATES, FIVE ASIATIC COUNTRIES, AND NINE EUROPEAN COUNTRIES. AMONG THE DISCIPLINES REPRESENTED WERE (1) ASTRONOMY, (2) BIOLOGY, (3) BIOPHYSICS, (4) CHEMISTRY, (5) CRYSTALLOGRAPHY, (6) ECONOMICS, (7) GEOGRAPHY, (8) GEOLOGY, (9) MATHEMATICS, (10) MECHANICS, (11) PLANT PHYSIOLOGY, (12) PHYSICS, (13) ZOOLOGY, AND (14) VARIOUS OTHER FIELDS. REPRESENTATIVES PREPARED AND DISTRIBUTED TO THE GROUP PAPERS REPORTING TEACHING DEVELOPMENTS FOR EACH DISCIPLINE. SIX WORKING GROUPS WERE FORMED, AND REPORTS OF DISCUSSIONS AND RECOMMENDATIONS WERE PREPARED. THE MAIN TOPICS CONSIDERED ARE (1) SCIENCE INSTRUCTION AND ECONOMIC PROBLEMS, (2) IMPROVEMENT IN THE COORDINATION AMONG THE DIFFERENT BRANCHES OF SCIENCE TEACHING, (3) PRE-UNIVERSITY INSTRUCTION IN SCIENCE AND THE EDUCATION OF TEACHERS, (4) TRAINING OF TECHNICIANS, AND (5) TEACHING CONCERNING NATURAL RESOURCES. NAMES AND ADDRESSES OF PARTICIPANTS ARE GIVEN. (DH)

ED020106

INTER-UNION COMMISSION ON THE TEACHING OF SCIENCE
(C. I. E. S.)

Congress on

SCIENCE TEACHING
AND
ECONOMIC GROWTH

Dakar, January 1965

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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SE002278

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INTER-UNION COMMISSION ON THE TEACHING OF SCIENCE
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Congress on

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ECONOMIC GROWTH

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Organised under the distinguished patronage of His Excellency the President of the Republic of Senegal and with the aid
— of the United Nations Organization for Education, Science and Culture (UNESCO),
— of the French Ministry of Cooperation,
— of the Ford Foundation.

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This Congress was organised by the *Interunion Commission on Science Teaching* (CIES) of the International Council of Scientific Unions (ICSU). Composed of the representatives of the Teaching Committees of ten of the Scientific Unions, members of the ICSU, (see *appendix 4*), the CIES studies the problems arising in several branches of knowledge, particularly with reference to the difficulties arising from the greatly increased number of students and the shortage of teachers. It is especially concerned with the aspects of problems peculiar to developing countries.

With these aims in view, and recognising the welcome conveniences offered by the University Faculty of Sciences, as well as to its travelling facilities, CIES chose Dakar as the meeting place for the first Congress to be organized by the CIES.

The President of the Republic of Senegal agreed to place the Congress under his patronage, the financial supports received from the ICSU, the UNESCO, the United States National Science Foundation, the French Ministry of Cooperation, the Ford Foundation, and the Asia Foundation made possible the circulation of many preliminary documents and the presence at the Congress of active participants.

The attendance amounted to 84 people (see *appendix 1*) drawn from nine African states, four American states, five Asiatic, and nine European.

The distributions according to specialities was as follows : Astronomy, 2; Biology, 8; Biophysics, 1; Chemistry, 3; Crystallography, 1; Economics, 3; Geography, 3; Geology, 3; Mathematics, 25; Mechanics, 1; Plant physiology, 1; Physics, 13; Zoology, 1; Miscellaneous, 18.

I. – PREPARATION FOR THE CONGRESS

At preparatory meetings, the CIES decided upon an extensive program for this first Congress, especially in the light of the agreements that were concluded between the UNESCO and the CIES (each of them contributing financial help), on the subjects to be considered.

Preparation for the Congress was carried out in three stages :

1. Every representative of an Union within the Commission was asked to prepare a report on teaching developments in his own branch of instruction and on the assistance he thought could be given to or received from other scientific disciplines. These reports (see *appendix 2*), prepared in due time to permit the best coordination for future work were distributed to all persons proposing to attend the Congress.

2. It was anticipated that six *working groups* would meet during the four days preceding the Congress. For each group, a convenor agreed to prepare a document to be used as a basis for discussion. These documents (see *appendix 3*) were also distributed to interested participants.

3. After each meeting of the working groups, it was proposed that each group should put forward suggestions for distribution to every Congress member.

These suggestions were ratified by the Congress, though new significant contributions were made by participants who had not been able to attend the working sessions or whom the simultaneous meeting of several groups had prevented attending one of them.

A summary of the proceedings of the Congress sessions is given below : the final reports, written at the UNESCO's request, will provide fuller details.

II. – OPENING SESSION

This session was honoured with the presence of the Ministry of Education of Senegal and the Rector of the University, Professor P. LELIEVRE.

After an address of welcome, tinged by humour, given by Professor H. MASSON, Dean of the Faculty of Sciences, Professor M. H. STONE, President of the CIES, recalled the conditions in which this Interunion Commission was created (see *appendix 4*). He went on to say that the development and the social importance of Science, the continuing increase in the number of students (in schools and universities), and the shortage of teachers, raise urgent problems in education. A complete change in syllabus and even in teaching methods, an investigation of the place of science in general education, and a combination of educational planning with economic planning were now very necessary. The President ended his speech by acknowledging the help of the authorities, the University, and all the officials in the organization of the present meeting.

Then Mrs. A. HUNWALD, on behalf of the President of the UNESCO, said the subjects of discussion at the Congress and the meeting place were particulary well chosen. At its last general meeting, the UNESCO decided to extend its activities in the field of Science and of the applied sciences in relation to economic development. Even in the scientifically more advanced countries, educational reforms were now needed; various studies in curriculum and method were being undertaken, the conclusions of which were to be pooled. After recalling the early UNESCO activities (through individual experts, pilot-planning, the circulation of pedagogical information, text-books and modern equipment, and the development of training colleges, technician schools, and post-university training centers), Mrs. HUNWALD showed how useful were the advice given by the different scientific Unions and the CIES. She particularly rejoiced at the possibilities of co-ordination afforded by the CIES; the proposals and suggestions of the Congress would be of great assistance, and the contacts established should be continued and further developed.

Finally, the Minister of Education expressed his satisfaction in the interest shown in problems that were of the highest importance to African nations — and of which African governments are very conscious. He wished a great success to the Congress in its work.

III. – SCIENCE INSTRUCTION AND ECONOMIC PROBLEMS

A number of studies have already been published on this subject, namely by the Organisation for economic co-operation and development (OECD) (1). The following three papers, reproduced in part, were presented at the Congress.

A. — ECONOMIC ASPECTS OF SCIENCE EDUCATION

(Professor M. H. Stone, Chicago).

History is the product of the human mind and geography — that is to say, the total sequence of human events is the resultant of the interaction between men's drives and mental abilities on the one hand and the constituents of the physical world on the other, as these are distributed in space, especially over the surface of the earth. In this context history is to be understood, obviously, as comprising political history, economic history, social history, intellectual history, and so on. Somewhat more narrowly, economic history is the product of human resources and natural resources. The interaction between these two factors may create, and often has created, a state of equilibrium; and the consequence of any marked imbalance — as for example between the demand and supply of foodstuffs — is an effort to establish a new state of affairs in which the balance has been redressed. Modifications in either of the factors may disturb equilibrium or alter the trend towards equilibrium. On the human side such modifications may take the form of accretions to knowledge, the development of skills or « know-how », the injection of new desires or drives, innovations in social or political organization, or the growth of populations. As for natural resources, these may be altered by consumption, discovery, and invention. It is a striking fact that most of the natural resources on which we depend today for energy were unused before the Christian era — water, air, petroleum and the radioactive elements were not previously availed of

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(1) We mention :
— Prévoir les cadres de demain (1960).
— Besoins scolaires et développement économique et social (1962).
— Aspects économiques de l'enseignement supérieur (1964).
— Politique de croissance économique et d'investissement dans l'enseignement (5 vol.).

for power : in earlier times energy was derived mainly from chemical or biochemical processes of oxidation involving the consumption of organic materials. The interaction between human and natural resources is effected in part directly, through manual labor, and in part through the mediation of tools, machines, energy sources and various organizational devices. What man can do with bare hands alone is extremely limited. The use of simple tools, such as the hand axe, originated in the very earliest prehistoria times. The industrial era originated with the invention of a large variety of tools and machines and the utilization of steam-power. Today we seem to be entering a new era in which what the machines of industry have done for the physical use of natural resources will now be done by the electronic computer for the intervention of the mind in the exploitation of those same resources. The role of the machine in facilitating and augmenting the interaction between human and natural resources involves a feed-back process whereby some resources are employed to produce the machines themselves. It is in order to describe and analyze this process that economists have introduced such terms as « capital » and « investment ». They have recognized also the importance of that sort of feed-back by which resources are employed to modify the human factor itself. However it is only recently that an intensive effort has been made — and with some success it would appear — to understand the quantitative aspects of what is now termed « investment in education » or « investment in human beings ». These terms are not used in any sentimental sense, but are conceptual tools in the study of an important element in the economic process. An important goal of a good theory of investment in education would be the development of formulae showing the incremental return to be expected from an increment in such investment. It seems that a good many economists are satisfied that they are making real progress towards these and related goals. Even if much remains to be done before a reasonably satisfactory quantitative theory is actually achieved, the analysis does give us a better understanding of the different mechanismus whereby investment in education produces a definite economic return and points toward a quantitative estimate of that return. It is to be regretted that we could not bring here a number of economic specialists to tell us in more detail what this emerging theory is like, but lack of money and lack of time stood in our way.

In planning for economic development, attention obviously has to be paid to the feed-back processes involved in capital investment and investment in education. The ability to understand these processes quantitatively is a prerequisite to precise planning, but qualitative arguments are enough to compel the planners to make some kind of provision for investment in education as well as in capital goods. It has been demonstrated in many ways that scientific research has been a most powerful factor in economic growth. One function of education is to provide the basis for scientific research by preparing the future research workers. Education also affects the economic process by developing the many kinds of human skill needed in the performance of a wide variety of tasks related more directly to that process. One component of the investment in education is the investment in the education of teachers. When education is extended to include special training for teachers, provision

is thereby made for a secondary feed-back of human resources into the educational process. The quantitative aspects of this feed-back are of urgent interest in planning education, especially in those situations where the demand for teachers is greater than the supply. The value of investment in education is, of course, enhanced by increasing in any way possible the role of return on the investment. Better curricula, better methods of teaching and better use of the educational plant or infrastructure all tend to increase this return appreciably.

Thus in their discussions of the teaching of science scientists should be conscious of the economic role of education. They should recognize that they can make important contributions toward increasing the economic return on investment in education by improving science curricula, the methods of science teaching, and the preparation of teachers. To the extent that these matters may be viewed quantitatively, scientists should make some attempt to go beyond merely qualitative consideration of the probable effects of their proposals. The significance that can be attached to these economic aspects of education does not, of course, justify giving them undue weight. The cultural values retain all the importance which has traditionally been attributed to them in the discussion and planning of education.

Finally, it may be observed that economic and educational planning involve techniques which fall in the provinces of mathematicians, statisticians, and computer experts. Without such techniques the application of economic theory to develop rational quantitative goals would hardly be possible. Thus certain kinds of scientist have direct roles to play in the planning process.

B. — EDUCATION AND DEVELOPMENT

Mr. A. Bouc
Director of the ISEA, Dakar

Educational problems have been intensively studied during the past years, namely education planning and costs evaluation. The Congress itself deals with the training of teachers and technicians, and with the pre-university teaching. I shall only consider less technical aspects and try to define two points :

— Introduction of education in the development process.

— Taking into account of development imperatives in the definition of an educational policy.

1. Education in the development process.

What is the economic profit brought about by education ? It is a complicated problem. I shall examine only two aspects of the question.

1) *Work productivity increase through education in the developed countries.*

A simple way of formulating a production operation is given by the so-called Cobb-Douglas function, in which a product P is considered as a function of a Capital amount K and of a working time quantity L, by means of adequate coefficients. Statistical and economic checkings of this function have shown in the United States over long periods of time (1889-1957) that P increases much more rapidly (nearly twice) than would have been expected from the K and L increases.

So, there is a residual production factor that may be called the *increased work productivity*. Obviously, one factor of this productivity increase is the education level. But it is rather difficult to isolate it from the capital productivity increase and from more general factors such as dimension economies due to an extension of the inland market.

Economists have gone further and tried to measure the economic education profit. Unfortunately, they did not succeed in getting scientifically reliable results. They have resorted to three principal approaches. The first is the one I have just spoken of. With the second, they tried to establish correlations between educational level and economic activity level.

Comparing different countries at a given time, they found a significant correlation between the schooling rate and the gross national product per head. But it must be admitted that this correlation is ambiguous, because in its turn the development allows an increase in education expenses. The causal relation is not shown.

Education and national product have also been compared in a single developing country. The result is a relation similar to the previous one but not showing the peculiar role of education.

It is also possible to compare the benefit rate or the business purchase with the educational level of employed man labour or with the amount of education expenses in business. To my knowledge, there never was systematic investigation in this field. Here also, it is difficult to find something else than an ambiguous correlation.

The third idea is to compare the incomes of educated persons with those of more or less educated persons. The education gain is thus expressed by the difference between the addition of observed incomes and the education cost for an individual or for the community. Here also it is obvious that the relation is not simple and that other factors than education may affect the income level (intelligence, position on the work market).

Moreover, this measure underestimates the gain for the community when a high educational level is achieved. This gain is in fact not *equal* to the sum of profits of educated individuals, but is *superior* particularly because spreading psychological transformations are a progress fostering element.

However, from the investigations already carried out in the United States, it appears that education obtains substantial profits for society, even though a mathematical expression for them proves difficult, unreliable, indeed impossible. They also suggest that an educational policy,

only based on labour requirements to be anticipated in the near future, would certainly underestimate the needs of the community which are more important than the sole production branch requirements. They lead to an inadequate educational effort.

This statement is particulary important where developing countries are concerned.

2) *Role of education in a developing country.*

The special situation of under-developed countries lies in the fact that ancient production methods and hence social structures and psychological bearings, usually going along with the former, are not able to answer the much experienced need for the least possible confort. The human cost, as we used to say, is not covered; the need for food, for sanitary units, the desire of the least possible culture, of a decent house, etc... are not fulfilled.

In such a situation where the human capital is threatened, the part of education as a development agency has a prior claim on education as a commodity which yields cultural satisfaction in a leisure time society.

The French economists essentially distinguish the growth, which is a simple increase in the country productions, from the development which is the general effect of structural economy transformations usually going along with growth.

Education is to play an essential part in the indispensable economy restructuring process. Modernization indeed requires deep changes in the behaviour towards labour and recent techniques.

« It is not enough that technical progress might be made realizable, it also must be accepted. The social structures are to be modified only if the minds are changed, if the social equilibrium supporting the standing customs is overrun. The struggle against illiteracy and a regular schooling are the first steps in this change » (1).

Teaching can be considered as an educational instrumentality in a broad sense, or an instructional instrumentality, if the educational task devolves upon the family. Such is the conception still prevailing in Africa. Now, this conception is not acceptable.

Actually, for the majority of the population, there is no complementarity but opposition between the elementary school contribution oriented towards progress and the traditionalist educational contribution received by the child from the family, the social and physical environment.

This opposition results in a very delicate situation where the child is torn between two different surroundings and in an inefficiency of teaching expenses. Solutions to this problem are on the one hand in a teaching system regarded as an educative agency in a broad sense, that is an agency for teaching how to think and how to behave. On the other

(1) Research work about industrialization in agriculture, edited by the Institute for Social Investigations, Grenoble University, July 1964.

hand a typical aspect of under-developed countries is that the fact for adults of acquiring literacy is as quite indispensable as the further step of going school.

Now it must be admitted that, although the importance of schooling is widely recognized, it is not the same for the education of adults, though not so expensive and economically more payable.

From the preceding remarks it follows that development is governed by an intensive educational effort. However, the imbalance that education is likely to introduce in a traditional economy is not necessarily a profitable one. In many cases it may even be a barrier to progress. Let us now examine some essential points in education policies, regarded as one of the chief incentives to development.

2. Some aspects of the education policies linked with the development effort.

1) The development implies an harmonious working of economic, political and cultural groups and hence intercommunication between these groups (1). But the African populations still largely consist in *not very communicative* groups close to more open ones. This economic and cultural partitioning may partly be *broken* by education and by the subsequent diffusion of informations.

An individual in a modern society is now considered as receiving an amount of informations a hundred times equal to that received in an under-developed country and 60 % of those informations are conveyed by reading (2).

These informations build up needs. Now, if the informations received through education are usually delivered with an explanation as to how meet those needs, it is not the same with informations by radio, newspapers and advertising. The opening to the outer world without a preparation of the environment to answer the stimulations that will not fail to follow, involves a frustration feeling and severely unbalanced economy.

2) It is all the same if the education system does not suit the economic needs of the country, if it cannot be integrated into the common effort of development.

This will occur if it is considered that education aims at picking up a selected class rather than bringing the mass of population to adopt a positive behaviour towards labour and technical progress, mainly in the rural world.

In most of African states, education is the way of accession to public offices. As a direct consequence, the rural part is deprived of its best elements and the graduate people accumulate in crowded towns

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(1) J. C. Pauvert : Tendances actuelles de l'éducation des adultes. Etudes Tiers Monde 1961.

(2) Planning problems in Education. Etudes Tiers Monde 1964.

where life conditions are quite different from those of their original surroundings.

Thus, school contributes to dig in the rural world into its own isolation and to restrain its modernization. « If the situation is not taking a better turn, the countrymen will be, for still many years, unable to check their own bills at the cooperative stores, to evaluate the efficiency of their investments, to inquire, to participate in the national life. Dominated by townsmen, they will become fatalists » (1).

This lack of balance between capital cities and rural parts is certainly one of the most serious economic problems in West Africa.

3) As a result, education, if it is to help the development, must not only be opened to the outer world, but it must also be opened to the *environmental life* reality. It must prepare the transformation of this environment. It must therefore closely link together theory and pratice. It must involve the greater part of the population.

Here an approach must be done to a problem which was not experienced by the colonial authorities, but which is evocated by the majority of African people who now take interest in teaching questions and even very recently by Mr. NIANG, who takes part in this Congress. It is the problem of language. Mr. NIANG very clearly explained that, in the case of mathematical teaching, french hearing and speaking require a real translation strain from the pupil. The use of French is not *natural.*

In the more general scope of basic education, Mr. MOUMOUNI in a recent book (2) has pleaded in favour of a teaching in vernacular in order to increase the efficiency of elementary school. He also suggests that, with a better start, pupils who entered the high school where teaching is in French, would be more proficient than in the present case. As a matter of fact, their turn for study is disturbed by enormous difficulties due to the use (in elementary school) of a language which remains, in rural environnent, a basically foreign tongue.

4) In conclusion let us make some comments on the definition of an educational policy as part and parcel of a development policy.

If education should be explained by the environment, obviously the knowledge of this environment is required. However, the knowledge of African realities is still rather backward.

So much in African history as in civilization, in pedology and probably in other branches of natural sciences, there still exist dangerous gaps in technics, not to mention economics. Scientific research must be developed, text books be written or improved.

This amounts to say that an effort for developing basic education needs go along with an effort towards the constitution or at least the augmentation of the knowledge fund of African life. So, in proportion as executives are educated, research workers have also to be trained.

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(1) J. BROCHIER : Diffusion du progrès technique en milieu rural. ISEA, Dakar.

(2) L'éducation en Afrique, Maspero.

This will be all the more necessary as education is not only the transmission of acquirements made by a group or a generation, it is also an *agency of progress.*

It is, therefore, useful to plan a development of applied research in Africa. In my opinion, it would be *ruinous* to fail the creation of research in an under-developed country under the pretext that it is a poor one. *For it has a greater need for research than any other.*

The African governments have become *suspicious* towards a number or alien « thinkers », namely economists, who had presented miraculous solutions to theory. This partly explicable suspicion may become baleful if it does not support the *African* research scientists who, gifted in spirit although few in number, will have the task to conceive the economic technical and cultural future of West Africa.

C. — NOTES ON THE ECONOMIC BACKGROUND FOR SOME WEST AFRICAN COUNTRIES

Dr. D. Sloan (Freetown, Sierra Leone)

Although we talk in terms of places, economic development really refers to people. It is quite unimportant if a place becomes uninhabited because people find that they can have a better life elsewhere. Wealthier countries wishing to help poorer people can do so not only by pouring in economic aid but by opening their doors to immigrants. I suggest that Australia provides more help toward economic development for people by means of its immigration and assisted passage policies than it does by its contributions under the Colombo Plan. It can be argued that 19 th. century U.S.A. similarly contributed more to economic development for people by its then lenient immigration policy than it has done since the war by handing over 2 millions of dollars to poorer countries. However, I shall talk in terms of places.

Economic development is as undefinable as education and must be treated for each country by itself. Values are not universal. We must not be misled by those misleading international tables of rates of economic growth. They are, in fact, statistical monstrosities which do not compare the same things. If economic development is defined differently by different communities, then education aimed at economic development may differ also.

Economists interested in development differ in the strategy they see as best. Immediately after the war, the popular strategy was to pour capital and know-how into poor countries, with the naive expectation that therefrom would result a magnificent and self-sustaining blossoming of the aided economy. Experience disappointed such expectations derived from highly simplified abstract macro-economic models. A second approach has been to insist that what must come first is the economic infrastructure — mainly power and communications are provided, then if the roads, railroads, harbours, electricity, etc, and industrialisation will follow at a gallop. A third approach, and probably

the strategy to which most of you present would subscribe, has emphasized the importance of education and health services.

No one of these approaches is alone adequate. For many countries there is more to be gained by forgetting the spectacular and setting out to do a little better those things that the country has done in the past — to work a little harder, to organize a little better. Marginal improvements in known fields are often more fruitful than grandiose novelties. For others quite substantial investment in irrigation of flood control may be necessary.

Now let me turn more specifically to the problem in hand at this conference. And may I say how pleased I was that M. Bouc brought us to West Africa in his talk, because much of the earlier discussion here could as well have taken place in New York or Edinburgh. Briefly here are a few facts about the economic situation in West Africa.

1. — In round figures the average expectation of life in North America or Western Europe is about 70 years, and you can devise an educational pattern with that in mind. In West Africa we do not know the corresponding figure, but it is probably about 40 years. So under American or European conditions you can plan to keep a fair number of people at university studying for their bachelor's, then their masters', and then their doctors' degree and coming out at 25 years of age or so, academically highly qualified though not dry behind the ears in everyday affairs. You expect them to mature in another two or three years, and the community gets the benefit of their services for 35 or 40 years. It is quite a different kettle of fish economically if average expectation of life is only 40 years — and not only in respect of university education.

2. — Most of the West African countries are predominantly agricultural and compete with each other in the world markets. For many of them any appreciable improvement in the average standard of living within the next 20 years must come via agricultural expansion. But if they all produce more cocoa, more palm oil, more coffee, etc, what happens to the prices at which these things sell ? Yet for any one country that can expand to agriculture first, this is the way to a higher standard of living. Greater diversification of agriculture is, of course, essential and some industrialization. But for many, there are more returns to be detained from sensible expenditure of one million pound on agriculture than on manufacturing industry.

3. — Most West African countries are small. — What numbers do you expect in your different educational institutions ?

4. — An educational program devised for Western Europe will not do for countries where illiteracy is common. For Sierra Leone the illiteracy rate is about 80 percent, and without mass adult education. This problem is insoluble within a reasonable time. And when you start from such a low literacy base, it is hard to speed the process.

5. — Some mention has already been made here of the variety of languages. In Sierra Leone English is the official language; Koro is

the lingua franca; Mende and Timne are spoken by relatively large groups; but six other languages are sufficiently important for the local broadcasting station to transmit a weekly news bulletin in them.

6. — Scientists and laboratories are expensive. For many developing countries it is not the capital cost but the recurring cost that is the higher. Capital can be had from a variety of sources fairly easily — the Ford Foundation, Commonwealth Funds, World Bank, French funds, etc. But maintenance and repair of engines in the engineering Faculty, replacement of breakages in the chemistry laboratory, and so on — these things are not cheap anywhere but they are doubly expensive in small countries without the trades and skills of Europe. It is very nice to get a gift of £ 1 million for a science building, but what is it going to cost in terms of salaries and general running cost from here to eternity ? The U. K budget is something of the order £ 7 000 million per annum; Sierra Lenoe's government budget is £ 17 million — or £ 8 per head per annum. Careful costing of expenditures is obviously highly important under such conditions, and there are other things to be bought besides science teaching.

7. — It seems to me, therefore, that for most West African countries the local educational system cannot be a frontiers-of-knowledge affair but a bringing in and spreading of already known techniques. Education that would bring into operation known agricultural techniques could do much for some West African countries in the next 10 or 20 years. Universities there must be, but in many only at the undergraduate level. Graduate schools, particularly in the sciences, are too expensive and graduate work can be done better overseas. There is much talk of African unity, economic co-operation, common markets and so on. However, most of these countries are newly independant, with a high sensitive and a relatively inexperienced public service, and they are not yet ready to subjugate their new nationhood to the burdens of effective co-operation. So it looks as though the pattern of education must be the teaching of teachers, the teaching of known skills and techniques — the advancement of science quantitatively rather than qualitatively.

D. — THE ROLE OF SCIENCE AND TECHNOLOGY IN THE DEVELOPMENT OF PAKISTAN

By Professor Dr. M. Ahmad (Dacca)

When Pakistan was established in 1947 the outlook was gloomy because 85 per cent of the population could neither read nor write, there were practically no industries and the yield from the land per acre was one of the lowest in the world.

To meet this situation, the Government appointed Commissions to study the defects education, science and agriculture and to propose remedies. Science was made compulsory up to class eigh and Arts and Crafts and Arts and Pratical Arts were introduced as elective subjects in Junior

High Schools. At the Secondary stage three types of schools, Technical, Vocational, and Secondary were planned. The Secondary schools retained the scientific bias introduced in the Junior High Schools. A large number of colleges and three new universities were opened. Existing science departments were expended and departments of biochemistry, geology, soil science, pharmacy, and microbiology were started.

To meet the shortage of manpower in the field of technology, two engineering colleges, six polytechnics and a number of technical institutes were established. Courses in mining technology were provided at some polytechnics. Two agricultural colleges and two agricultural universities were opened to treble the output of agricultural graduates. A forest college was started to train staff for the forest department.

Five autonomous Research Councils were sponsored by the Government for the organisation and co-ordination of research in the fields of agriculture, industry, medicine, engineering and atomic energy.

Research work in the field of agriculture has been entrusted to the Agricultural Research Council. The Council and the Department of Agriculture have brought under cultivation an additional 1.6 million acres of land. The production of food grains has increased from 12.9 million tons to 15.3 million tons per annum through better irrigation, drainage, the use of fertilisers, improved seeds, and by spraying about twelve per cent of the total acreage under cultivation.

A Water and Power Development Authority is harnessing the water resources of the country for irrigation and generation of power. Through hydroelectric power projects a power potential of about 320,000 kilowatts has been organised. Fuel and mineral resources are being developed rapidly and large fields of natural gas, seams of coal and peat and deposits of a variety of minerals have been discovered.

To be able to use atomic energy in industry, agriculture, and medicine, the Government has established an Atomic Energy Council. It has set up four laboratories and plans are ready for two nuclear power plants, and an Institute of Nuclear Science and Technology. The Pakistan Scientific and Industrial Research Council has set up four laboratories to conduct research and help industrialists increase their production.

A National Science Council has been established to advise the Central Government on all matters connected with the development of science and technology, to coordinate research and to avoid duplication of scientific work conducted under the various Research Councils.

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Following up these substancial papers, Professor B. THWAITES pointed out the risks involved in a teaching organization essentially based on an economic efficiency criterion. (Education has indeed many other tasks, namely moral and cultural).

Professor D. SETTE wished that a report should be written (perhaps under UNESCO's patronage) on the teaching problems peculiar to countries having the most rapid developments and the most urgent needs.

Professor H. FEHR drew attention on the World unification and on desirable intercourses between various cultures.

IV. – IMPROVEMENT IN THE COORDINATION AMONG THE DIFFERENT BRANCHES OF SCIENCE TEACHING

A) MATHEMATICS FOR PHYSICISTS

The Working Group C, comprising Professors Y. Akizuki, S. Bundgaard, A. Delessert, R. Faure, H. Fehr, P. Fleury, B. Haidara, A. Lichnerowicz, M. Minnaert, C. Pisot, E. Schatzman, I. N. Sneddon, M.H. Stone, S. Tanbunuyen, R. Taton, takes into account the preliminary reports of Professors C. Pisot and H. Fehr, as well as those of Professors Y. Akizuki and G. Temple (see above) and some publications of the OCDE (namely, Mathematics for physicists and engineers).

On behalf of this group, Professor Pisot presented the following suggestions which were ratified by the Congress, except for a few details.

General principles

1) Education should proceed by successive approximation. At each step, part of the subjects should be taught with all possible exactness and vigour, whereas other matters could just be formulated, the theorems being given without demonstrations, for the purpose of pratical use. It is quite necessary that the teacher distinguishes between these two aspects of his course.

2) The subjects of the program should not be a matter of further development.

3) As far as possible, the succession of the subjects should be chosen in agreement with the succession of the subjects treated by the physicists; it is wished that a close cooperation of the teachers in physics and mathematics should be established.

4) The exercices should be taken, as far as possible, in various fields. of physics or astronomy.

Secondary school programs (Years 14-18)

In agreement with the report of Professor Fehr, the committee suggests that the following subjects should be taught in secondary schools :

A (1)	B (1)
Theory of sets	Real numbers
Relations	Graphics. Integrals
Fonctions	Primitives
Group theory	Logarithms
Integers	Slide rule
Complex numbers	Vectorial functions
Trigonometry	Linear programming
Vector space	Elementary probability and statistical theory
Calculus	
Differential equations with constant coefficients	
Linear and homographic group	
Analytical geometry	

Ist cycle of university or last two years of college (Years 18-20)

A	B
Linear algebra, eigen values	Elementary mechanics
Abstract algebra	Special relativity
Riemann integral, approximate evaluation	Partial derivatives
Series	Multiple integrals
Simple differential calculus	Integrals on the manifolds with extension of differentiations
	Stokes' formula

(1) Throughout, colum A refers to the subjects which should be taught with all possible exactness and vigour (at a certain level); column B refers to the subjects given without demonstration.

2nd CYCLE OF THE UNIVERSITY (Years 20-22)

The committee wishes that education in mathematics take two years, with one and one-half hours per week.

A	B
Normed vector space	Distributions
Linear operators	Fourier transform
Pre-Hilbert space, eigen values	Convolution
Fourier series, orthogonal series	Probability theory :
Self-adjoint operators	probability laws
Integral operators	characteristic functions
Differential equations	χ^2-test
Green functions	« Student's » t - test independence
Partial differential equations; separation of variables, characteristics (hyperbolic equation)	Differential equation
	Poincaré's theorem
Differential calculus	
External differential calculus (Stokes' formula)	
Functions of a complex variable	

In numerous discussions (Professors S. BUNDGAARD, P. FLEURY, T. N. GEORGE, P. LORRAIN, P. MARRIENS, M. MINNAERT, E. SCHATZMAN, D. SETTE, B. THWAITES) attention was drawn to the following points :

— The proposed program of Mathematics must be re-arranged and distributed in the time-table, according to later proposals of the Union of Physics Teaching Committee;

— A certain flexibility must prevail in the distribution of the subjects which should be taught with exactness (column A) as opposed to other subjects (column B);

— The teaching time devoted to mathematics should be fairly distributed with respect to other sciences;

— In each country allowance must be made for local traditions and methods;

— Importance should be attached to numerical computations and role of electronic computers;

— In relation to computers, the teaching of mathematics should be re-examined and should deal essentially with discrete phenomena;

— The introduction of the « New Mathematics » in teaching is still at an experimental stage, and « secondary modern school » students often seem less fitted than « secondary grammar school » students to use equations and integrals needed by the physicists;

— A collaboration between mathematicians and physicists is absolutely necessary (relatively few physicists attended this Working Group).

Professor P. LORRAIN called attention to the 1964 June issue of the American Journal of Physics in which appeared interesting papers on the teaching of mathematics. (See also the 1964 September issue of « Scientific American »).

The final report will be prepared by Professor PISOT. It will be edited by UNESCO and included in the volume « New ideas on the teaching of Mathematics » to be published early in 1966.

B) MATHEMATICS, PHYSICS AND CHEMISTRY IN THE TRAINING OF BIOLOGISTS

The reports of Professors R. HELLER and P. CHOUARD, and various publications of the OCDE (for a new teaching of Biology, Modern Chemistry, etc.) were the main topics in the discussions of Group A, and later of the Congress. Participants included Professors M. AHMAD, J.S. BAER, L. CHAMARD, J. MIEGE, M. MINNAERT, C. PISOT; V.E. SAHINI, D. SETTE and G.M. SCHWAB.

The following suggestions were noted :

1) The need for a thorough grounding in Mathematics, Physics and Chemistry, for all biologists, was again emphasized, including the need of those who are much interested in the dominantly descriptive branches of biology, on account not only of the instruction provided by these basic sciences, but also of the intellectual discipline they give. Three stages of instruction were envisaged : the first, to be achieved by everyone, corresponds to the secondary school and to the junior years at the University; the second, somewhat higher, is recommended to those who intend to take up experimental or quantitative observations; the third concerns more particularly the students in certain branches of biology (notably genetics).

2) Programs have been devised for the first two stages. They try to combine the exactitude in measurement and knowledge (e.g. notions of modern mathematics or of quantum physics) without departing too far from the essential needs of biology.

3) Teaching must be specifically adapted to its particular purpose. Pratical work, exercices, and guided activities are of capital importance. The distribution of topics among basic sciences (mainly physics and chemistry) must avoid fragmentation and repetition.

4) No exclusive method is proposed for the selection of teachers, provided the foregoing imperatives have been allowed, for instruction is as kell given by a scientist interested in Biology or by a biologist qualified in basic science.

5) The curriculum should be such that in the junior year at the University the hours devoted to basic sciences do not exceed two thirds, or at most three quarters of the whole time-table.

6) Refresher courses are necessary.

7) At the end of pre-University study the pupils must recognise

the place of Biology as an integral part of a wider general culture. This implies a training of teachers and pupils in basic sciences.

The final report devised by Professor HELLER will be issued in the publications of UNESCO referred to on page 23.

C) THE PLACE OF MATHEMATICS IN THE TRAINING OF GEOLOGISTS

The Working group B, comprising Mrs. A. HUNWALD and Professor P. BELLAIR, R. CLOZIER, H. FAURE, A.J. FRUEH, W. JACOBSON, P. PELISSIER, with Professor T.N. GEORGE in the Chair, was able to use the two reports prepared by the Chairman, as well as his « Syllabus and Methods in the teaching of biology ».

The views expressed by members of this group and by other participants in the Congress can be summarized as follows :

The Commission noted the almost total neglect in a number of countries of the formal teaching of geology in secondary schools. It considered that such neglect needs urgent remedy, most effectively accomplished perhaps less by the incorporation of a separate « subject » of geology as an addition to the existing curriculum than by the integration of a comprehensive Earth science with other sciences (physics, chemistry, biology) in a unitary general science. It did not imply that a single teacher should be responsible, at senior levels in the secondary school, for the teaching of such a wide-ranging science; but it emphasised the need for a radical revision of curriculum to ensure a breakdown of the extreme « subject » specialisation that now afflicts school teaching. In the context of a generalised science, school mathematics should be both an intellectual discipline in having its own internal validity, and an instrument whose use in the growth of science, including geology, should be more actively presented to pupils. The Commission noted and regretted the general lack of geological examples in mathematical texbooks.

The Commission agreed that geology in the junior years at the university was normally sufficiently well served by senior-school or propedeutic mathematics. The specialisation that took place in senior undergraduate years (notably in petrology, sedimentology, palaeontology, structural geology, geomorphology, and geophysics) demanded, however, instruction in mathematics beyond elementary undergraduate stages. Notably, this should include, according to the field of specialisation, instruction in statistics and in differential and integral calculus. The training of professional geophysicists further demanded a thorough grounding not only in geology and physics but also in an advanced mathematics at a stage comparable with that needed by specialist physicists.

While administratively it was difficult, except in the larger universities, to provide special instruction for relatively small groups of students, short courses *ad hoc* in a service mathematics adapted to geological needs and based on a suitable propedeutic foundation, were those most suitable for senior students. They should be illustrated by an abundance of geological examples, and there should be available textbooks in mathematics designed especially for the use of geologists.

A more detailed report, prepared by Professor T.N. George will be issued in the publications of UNESCO referred to on page 23.

V. — PRE-UNIVERSITY INSTRUCTION IN SCIENCE AND THE EDUCATION OF TEACHERS

The working Group D, was animated by professor H. Fehr who had prepared an extensive paper on the teaching of mathematics. This group was also able to use the information presented in most of the reports of which a list is given in appendices 2 and 3 (1). A large number of the participants took part in an exchange of viewpoints, which resulted in the following suggestions.

A. — THE TEACHING OF MATHEMATICS (H. Fehr)

1. The proposed program. a) *Elementary School.* Set recognition (only disjoint sets). Cardinal number. Order. System of numeration. Operations on fractions. Equivalent class of fractions. Rational numbers (positive). Measures. Calibration of a ray. Decimal notation for rationals. Theory of percent. Extension of the ray to include negative rationals (the number line); pratical applications. The nature of physical Euclidean space. Point segment, path, ray, line, plane, curvilinear figure. Closed curve (common polygone and circle). Region in a plane and in space. Common solide. Measures of length, area, volume. Practical applications.

b) *Secondary School.* Sets of numbers and of points, Mappings. Relations, functions, the number systems E, Z, Q, R, C, and their properties; the equivalence and order relations; algebraic structures Group, Ring, and Field; solution of equations and inequations in one and two unknowns over a given field. Simple applications to linear programming, vectors, vector spaces, two and three dimensional geometry, linear algebra, combinatorial analysis, probability, statistics, the calculus, numerical analysis and the electronic computer. Graphical methods are assumed throughout the program.

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(1) We mention also several publications of the OECD.
— New Thinking in School Mathematics (1961).
— Sypnopses for Modern Secondary School Mathematics (1962).
— Mathematics To-Day, a Guide for Teachers (1964).
— Mathematics for Physics and Engineers (1961).
— A Modern Conception of Instruction in Physics (1961).

2. MODIFICATIONS FOR MASS EDUCATION. The same program, taken at a slower pace, less deeply, and with many more applications should be the curriculum for all pupils. It is possible to arrange a sequence of essentials for the less capable or the less prepared, so as to enable them to understand mathematics regardless of the stage at which they have ceased their formal study.

3. TRAINING OF TEACHERS. Looking at the proposed program, a teacher should be thoroughly competent in all the topics at a level far advanced from that at which it is to be taught. Hence, the university study and post-university study should cover the same topics in an extended, deeper, wider, and more rigorous manner. Added to this must be the psychology of learning mathematics and special techniques of teaching, with proper supervision of his apprentice teaching. But also, the teacher must continue his education of mathematics throughout his professional career.

Herewith is also a summary of the presentation of professor W. J. JACOBSON.

B. — SCIENCE EDUCATION AND ECONOMIC GROWTH

(W. JACOBSON)

CENTRAL THESIS :

The development of science programs for the primary schools and the secondary schools is a highly sophisticated and creative act : all good science programs make a difference in the way people live. Science programs in various regions and nations will have certain common elements related to the nature and structure of science and certain distinctive elements related to the culture, society and economy of the region or nation.

FACTORS TO BE CONSIDERED IN PLANNING SCIENCE PROGRAMS :

1, Nature of science; 2, Nature of the learner; 3, Past experience and research; 4, Nature of culture, society and economy.

DISTINCTIVE ELEMENTS :

1, Wise use of natural resources : Example : a) Soil and soil chemistry; b) Water and sanitary water supply; c) solar energy; d) Plant resources; e) Animal resources.

2, The human body and its care. Example : a) Nutritional deficiencies (Kwashiorkor); b) Infectious diseases (Dysentry; malaria, bilharzia, etc.).

3, Control of population. Example : Analysis of reproduction in terms of critical stages.

4, Skills and understandings. Examples : a) Scientific literacy; b) Use of electricity; c) Proper care of plants and animals; d) Basic principles of machines.

5, Learning to learn. Examples : a) Local sources of new information; b) How to appraise new ideas.

COMMON ELEMENTS :

1, Basic assumptions of science. Example : The universe in which we live can be described and explained in a rational way.

2, Broad generalizations of science. Example : The conservation of matter and energy.

3, Processes of science. Observation : Example : Observing characteristics of plants grown with and without certain nutrients. Classification : Exemple : Building a key for the classification of rock-forming minerals; Identifing local minerals. Measurement : Example : Measuring temperatures in various devices for collecting solar energy. Experimentation : Example : Controlled experiment comparing growth of plants in saline and non-saline soils. Prediction : Example : Study of snail populations in acquarium or pond and predicting future populations. Model Formation : Example : Developing model of electrical system. Communication : Example : Science conference where children report on their studies.

4, Mathematics in primary school science : Examples : a) Numbers and units; b) Development of scales for measurement; c) Measurement of distances, volumes, weight, mass, time, temperature, angles, etc.; d) Graphing; e) Space-time relations; f) Estimation; g) Simple tests of significance.

TEACHER EDUCATION :

1, Broad general background in science including laboratory work;

2, Work in special methods of teaching science including experience in dealing with science problems such as children will study and in the use and construction of science materials and equipment;

3, Introduction to primary school science syllabi, books, films and other teaching materials;

4, Teaching practice with primary school children in science.

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A considerable discussion was given to means of instrumenting good science and mathematics programs in the developing countries.

C. — GENERAL PRINCIPLES IN SECONDARY SCHOOL TEACHING OF MATHEMATICS AND SCIENCES

(M. MINNAERT)

TEACHING.

The programs should be set up by a cooperation between scientists, pedagogists and teachers. Good reference textbooks for teachers are of great importance.

In order to introduce a modernized program in a country it is necessary to :

a) try to interest a group of people;

b) introduce the preliminary program in some pilot-classes;

c) have the programs and the examinations changed.

It is desirable to introduce some history of science in the course of history, some philosophy of science in the course of philosophy. Some parts of mathematics and science can be taught according to the historical method.

For each science there should be, if anyhow possible, practical exercises by the pupils.

TEACHERS.

Considering the lack of secondary teachers, especially in newly developing countries, we must accept the following *minimum requirements :*

Teachers at elementary schools should be educated at the secondary schools and follow a complementary pedagogical course;

Teachers in the lower classes of secondary schools should have studied during at least two years at the University; they also should follow a complementary course;

Teachers in the higher classes of secondary schools should have studied during four years at least at the University and should also have followed a complementary course.

The pedagogical training should extend over 1/2 year-1 year, it might take place either during the scientific studies or later. It should include :

pedagogics of adolescence;

special didactics of the science to be taught;

a stage in secondary schools and practical exercices in teaching;

a course in the history of science and a course in the philosophy of science.

After the teachers have left the University and have got their position, they should follow some post-academic courses, informing them about new progress in their science.

The lack of teachers for secondary schools is due to several causes, among which the most important are :

1) the insufficient salaries, which in most countries are considerably lower than in the industry;
2) the insufficient pension, the too great number of teaching hours, the too great number of pupils in each class.

It is so important to have good teachers, that all effort should be made in order to improve the financial situation and to improve gradually the other conditions of working.

For *newly developing countries* the following advices may be given :

teaching should start from the direct environment, the local traditions and surroundings;

pure memorization should by all means be avoided, pupils must understand, come themselves to conclusions, rely on their common sense;

give great importance to the formation of good teachers, they are even more important than research scientists or industrial scientists;

when you send young people abroad for higher scientific training, make them officially sign that they will come back to their country, and take care that they find adequate positions when they return.

In the lower grades there should be some elementary astronomical observations.

Some special recommandations :

In one of the highest classes of the secondary schools there should be a systematic course in *astronomy,* centred on the structure of the Universe and astrophysics. Already a course of one hour a week would have a very high educational value.

In newly developing countries, *chemistry* should be connected primarily with biology and geology, even more than with mathematics. This will allow the chemist to take part in the development of agriculture, soil fertilizing, nutrition.

Biology in secondary schools should be modern biology, based on physics and chemistry. The teacher must have studied not only descriptive biology but also physiology; he must have done practical work.

Teachers in *geography* should be trained at the Universities or at institutes of a similar scientific standing. They must not only follow courses in social geography, but also courses in mathematics, meteorology, biology, geology, etc., so that they get a broad scientific formation.

In newly developing countries the teaching of geography at secondary schools might start by a treatment of the tropical zone, then of the temperate zone, finally of the polar zone.

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Among the remarks presented at the conference, we call attention to those of Professors Agiabu Kemmer, M. Ahmad, Y. Akizuki, J. Aspers-lag, B. de Finetti, P. Fleury, J. H. Gay, T. N. George, L. Kuipers, P. Lorrain, P. Mariens, I. Raw, D. Sette, I. Sneddon, R. Taton, B. Thwaites.

The last named presented the « School mathematics project » now conducted in Great-Britain (6 books plus Winchester Calculus and Director's Report).

Several participants expressed the view that the reforms in mathematical instruction should not be too severe, but should permit an approach as adequate as possible to actual problems requiring accomplishment in numerical and algebraic computation.

Professor H. Fehr's final report, designated for publication by UNESCO, is of particular importance (See also the program of work of the CIES, appendix 1 at the end of this report).

VI. – TRAINING OF TECHNICIANS

Professor M. Y. Bernard who wrote the preliminary paper on this subject was unfortunately unable to come to Dakar. The discussions of group E, kindly conducted by Professor J. Robin, have been summarized by him as follows :

1. The group unaminously recognizes this problem as critical for the present civilization.

To carry through the study of this problem, a large information scheme must previously be devised, in asking a great number of states to let the convenors know the results from solid inquiries conducted by specialized committees inside every country, on account of the needs, the basic principles and the results acquired (if possible, qualitatively and quantititively by making use of statistics, methods, programs). Then the convenors should meet and bring all documents together.

2. The first three chapters of Mr. Bernard's report deal with general problems of techniques, technicians, their training and their promotion. This method is more rational than trying, as previously proposed, a separate training of high qualified technicians (what implies an exact definition of this term).

It must be noted that a lack in technicians exists in many branches of science. Higher technical studies must not be under-estimated with respect to theoretical studies, neither on account of different denominations of the obtained grades, nor by differences at the recruitment level. This is required to ensure the excellence of the technical managing staff needed by the country and also to have a sufficient number of candidates oriented toward technical careers.

3. In our opinion it would be necessary to prepare two quite separate reports : one dealing with the rapid training of the technicians needed by developing countries (the subject should be there considered as a whole); the other dealing with high qualified technicians, always distinguishing between developing countries and more developed countries (a few problems such as of polyvalency or of convertibility arise in fact all the less frequently as the countries are gradually developing; any too exhaustive specialization in a developing country may lead to raise the number of positions and to incomplete employment, even to unemployment in certain branches).

4. In every developing country, the problem of technical training is associated with the problem of planning. Most of these countries now

have a Ministry of Planning and a Ministry of Technical Training. These ministries are entrusted in bringing about, with all possible accuracy, an idea of the state resources, of the needs and of the implementation required to meet those needs.

This demands a skilled staff indispensable to the country development. Therefore, the problem already prevails of training specialists, who are likely to carry out the research work in order to meet the needs of a developing country.

5. Moreover, it is necessary to take into account several classifications. For instance, an attempt must be made to find out what are, in order of urgency, the needs for technicians in stock-taking, infrastructure, maintenance, agriculture, and industry. Obviously every category (1) should exist simultaneously, but their development in time must be different.

6. Attention must also be drawn to the possibilities of education of technicians as a function of the technical level of the country. The following categories may be considered :

a) *Designing engineers.* At present, except for certain categories which are specific of a country, the education of natives is carried out over seas and a major part of the designing engineers is still recruited through the technical Assistance. This overseas education may have political incidents and somehow engage the government. For instance, an engineer, having learned how to use the equipment from an advanced nation will keep in touch with the nation and place orders with it, whence an actual bond, that may influence the social and ideological evolution of the country.

b) *Production engineers.* The term « qualified technicians » is perhaps more appropriate, if the « designing engineers » are regarded as the highest category.

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(1) The different categories are defined below :

Stock-taking :
— determination of mineral, agricultural and human resources;
— geological investigations;
— geological and geographical measurements;
— hydro-electric power;
— mapping.

Infrastructure :
— roads, railroads, conveyances, buildings, harnessing of rivers.

Maintenance :
— mechanical equipment (cars, tractors, trucks, locomotives);
— electric equipment (motors, conveyances of power);
— craftsman's tools.

Agriculture :
— education of agricultural instructors;
— education of peasantry ;
— technical improvement of cultivation (draught-animals, fertilizers, rotation of crops);
— introduction of new cultivations.

Industry : depens upon the chosen industries, their installations being decided by the Plan.

As strangers should gradually (according to the possibilities), be superseded by nationals, this category must be trained as far as possible on the spot in training schools, and for practical training in collaboration with the firms themselves. The specialized categories, necessarily reduced in number, would still be educated overseas, but less and less.

This category is mainly connected with the foregoing classification of technicians (in stock-taking, etc.). In each country, training will become possible in proportion as businesses related to those various branches are developing.

The efficiency of training schools would be higher if they can be reduced in number by grouping several countries together.

Here the technical Assistance may be of value in the form of teacher loans (temporary schools : e. g. specialized courses for three months or instruction for a year).

It is more advisable to train these technicians on the spot with alien teachers, if necessary, than to send students overseas. As a matter of fact a student is likely :

— not to come back, even though his studies have been made possible through assistance of his country;

— to carry on his studies toward the highest levels or toward another science, when his country quickly needs him essentially in the science and at the level for which he as been sent overseas for education;

— to adapt himself to a sociologically different environment what may involve other problems.

c) *Technicians and skilled workmen.* They must be educated in special training centers and by the firms themselves.

At the present time those categories are those which are most needed by developing countries.

7. Emphasis must also be laid on the way how to achieve the development of these countries.

It seems necessary to try an improvement of some existing skills. For this purpose, one must find out what can be used in the old methods and try some improvements that do not disturb the habits too much and that are of much acceptance. It is likely that only a few ancient skills might profitably be improved (e. g. in handcraft, cattle-raising, cultivation). But one should not start from the view point that ancient skills *must* be improved, for in many cases this would lead to a real revolution.

For instance :

— electrification in handcraft leads to electrification problems and disposal of products;

— increased possibilities of land cropping (draught animals instead of man power, suppression of fallows to make up for demographic increase) may lead to an impoverishment of the land, yet poor enough : then a complete modernization becomes imperative (rotation of crops, judicious use of fertilizers, implantation of new cultivations, etc.).

Furthermore : introduction of new skills in industry. The evolution of techniques in today's world is too rapid for an improvement of

local techniques (e. g. metallurgy, weaving...) to be profitable : this improvement would not be so rapid as the world progress.

8. Obviously in a few hours of discussion our group could not pretend to solve this far-reaching problem. At the utmost, it is hoped that from the lines above some of them will be of value to those who may have the privilege to start again this study on a larger scale.

The group regretting the absence of Mr. BERNARD, is pleased with having had the extensive document he had prepared for the discussions.

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During a Congress session, with Professor SCHATZMAN in the chair, various remarks were presented which are summarized below :

Prof. B. THWAITES. — It is probably not fitting to spend too much time in the search of general principles, when the needs are so different from one country to another; conferences held by small groups of countries having identical features and situations would be more advisable.

Prof. I. N. SNEDDON. — It would be disastrous if the technicians of developing countries, when educated overseas, could not be fully employed on their coming back.

Prof. D. SETTE. — All the technicians, ranging from the research engineer to the skilled workman, are so diversified that they could not be considered as a unity. A considerable effort of classification is being made by the OCDE (1).

The education of technicians could be organized with the help of UNESCO and a larger use of TV techniques.

Prof. P. LORRAIN. — It would also probably be of interest to devise a programmed teaching, that would of course allow for the psychology of the users.

Prof. W. J. JACOBSON. — The rapid change in the techniques makes it necessary to offer the users the possibility to keep themselves informed and more skilful.

Prof. Y. AKIZUKI. — Care should also be taken that not only work methods are taught, but also basic principles are explained to the technicians.

Prof. E. V. EMOVON. — The need for technicians in the research laboratories is particulary urgent. The Ibadan University looks to the education of technicians in science and medicine.

Prof. G. M. SCHWAB. — In Germany, in the field of chemistry, there is a lack of technicians being trained for a relatively short time, whose position lies between the workmen and the University doctors.

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(1) See among others :
Mathematical training of the engineer at the age of computers (1963).

M. P. Bandyopadhyay. — The technicians have to be regarded as belonging to the scientific staff and efforts must be made to sweep away certain social oppositions which are against their enrolment.

Prof. F. V. Diop. — Information means have to be developed, but also orientation means according to everyone's needs and abilities.

Prof. I. Raw. — A certain versatility should be ensured at the secondary school level.

M. A. Bouc. — It seems necessary to increase the number of scientists and economists whose task it is to anticipate *future needs,* misunderstood as yet, mainly in Africa.

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It has not been anticipated that after the Dakar Congress a general report on the education of technicians should be issued immediately : the problems raised demand new enquiries, but they still remain on the agenda of the CIES (See *appendix 4,* at the end).

VII. –TEACHING CONCERNING NATURAL RESOURCES

The extensive preliminary report of Professor J. Baer (1) was used by the Working Group in which have taken part among others M. Ahmad, M. Bodard, P. Cachan, P. Chouard, R. Clozier, Miege, Moral, P. Pelissier.

On behalf of this group the following text was presented to the Congress :

1. What is meant by conservation and exploitation of natural resources.

Are only considered here the renewable natural resources and chiefly soils, water, flora and fauna, whereas non-renewable resources such as mineral deposits, coal, etc., and unexhaustible sources of energy : sun, volcanoes, winds and tides, etc., are excluded.

The idea of conserving and exploiting renewable natural resources consists in maintaining a balance between nature and man and not in an absolute protection of nature against man. It is therefore necessary not only to determine and to teach the principles by which nature is protected, but also to place at the disposal of man precious but fragile natural balances : in other words, to avoid irreversible degradations that do not benefit man.

These problems, already acute in temperate lands, must be urgently studied in tropical countries. It is a fact that knowledge acquired in this field in temperate lands cannot be applied directly to developing countries, where exploitation, management and conservation of natural resources must be established in such a way that they may be continually renewed whilst maintaining the ecological balance. Therefore one of the major problems is that of teaching such knowledge. UNESCO, with its very extensive audience, should have a determining influence here.

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(1) UNESCO has recently published the final report of the Lagos Conference : « Scientific Research and Staff training in Africa with regard to study, preservation and use of natural resources » (1964).

2. Examples of natural balances created traditionnally by man.

The maintenance of certain ecosystems is assured by various Africa populations. A few examples can be given.

One of the most remarkable concerns the agricultural practices of the Sérères. In the Soudan-Sahel zone, where the climatic conditions are very harsh, destruction of the plant cover has particulary nefarious consequences. The Sérères of the Senegal have succeeded in establishing an association of agriculture and cattle-raising which remains in balance with this ecosystem by protecting and propagating *Faidherbia* (*Acacia*) *alba*. The biology of this tree has been used to the advantage of agriculture. The very tough seeds germinate after passing through the intestinal tract of the cattle. The young bushy plants are pruned at an early stage of their growth so that they develop into trees beneath which it is possible to grow food-plants. These trees shed their leaves during the rainy season so that millet and peanuts benefit from the full light which they need. Te leaves grow at the beginning of the dry season and protect the soil from the heat of the sun also providing together with the seed-pods, food for the cattle. The latter assures the manuring of the soil so that its fertility is maintained better than when chemical fertilisers are used. This type of agro-pastoral economy is very favourable and makes it possible to feed an increasing population. Densely populated areas coincide with stands of *Faidherbia albida*. This form of agriculture is in contrast to that of the Ouolof's who degrade the soil by intensive growing of peanuts. On the other hand, the traditional Sérère farmers are not well integrated into the modern way of living, being unused to commercial practices and to more successful types of economy.

Traditional civilization have realized, empirically, other types of ecosystems. They have, for instance, protected by management and improvement several natural stands of a particular species : Shea butter tree (*Butyrospermum paradoxum*), Locust-bean (*Parkia biglobosa*), Oil palm (*Elaeis guineensis*), etc. Even the so controversial bush-fires may be justifield when carefully controlled. It is necessary here to distinguish between the limited, domestic fires justified by agricultural practices and the destructive influence of the huge wild bush-fires.

In Southern Africa, herds of wild Kudu and Springbok are found to be of greater economical importance in the long run than cattle.

Outside of Africa, in Israel, the former practices of the Nabatheans in the Neguev have been re-established. By rational use of the run-off and by collecting all the water over thick silt deposits, it has been possible recently to extend cultivation in these areas which have suffered so much from dryness.

3. Educational value of these examples.

Here is good teaching material, but many difficulties will arise. There are, for instance, few intellectual elites among the traditional

peasantries, and younger elites are too often detached from their traditional practices.

The adoption of modern techniques in tropical lands too often is far from successful. When traditional native techniques are not recognized, there is a danger of an agricultural recession. Good examples of this may be found in South America.

Erecting large building, the possession of atomic piles, establishing important university centres with modern equipment are only one all round aspect of development. But the latter must also rest upon a broader basis, such maintain large untouched natural areas that will prevent downgrading of the surrounding land.

One of the essential tasks of the teacher will be to infuse these traditional methods which have proved to be scientifically valuable, and to improve them.

4. Present state of the problem.

As has already been mentioned in passing, methods for the conservation of nature have been established in temperate lands. In such countries conservation measures have often been taken at the last minute; they are, however, appropriate. But the experience thus gained is not automatically appropriate for tropical countries. There is no doubt that the problems are basically identical but the parameters are entirely different and everything concerning biology must be studied on the spot.

Therefore, one of the main obstacles lies in the absence of qualified personnel to teach methods which can be applied directly to the intertropical regions.

Sending African students to Europe is undesirable since their training will be valuable for Europe but not for Africa. Teachers coming from Europe to Africa will teach European methods, since they will be ignorant of local conditions; but it is primarily these which must be recognized.

Consequently, one of the principal aims is the training of teachers having both a good knowledge of conservation and exploitation of natural resources and of the conditions in Africa or other developing countries. In view of the paucity of qualified personnel and the high cost of establishing laboratories, such a curriculum, if is to be successful, can only be taught in a few privileged places. One must avoid creating too many, poorly-equipped centres and bring to a halt all projects that have been planned too big and therefore inefficient.

The problem must be analysed at different levels, viz. university, secondary schools and primary schools.

5. Trends and methods.

a) University level.

Subjects embraced

Teaching at this level is of primary importance, and courses can only be for post-graduates who already have acquired the basic knowledge of botany, zoology and geology.

At this stage; the courses should be synthetic by nature, a higher form of general ecology including man, the key being the concept of habitat. This implies conservation of the flora, animals and soils. Whenever man intervenes, he must continue to do so but by making rational use of natural resources and even increasing them for the benefit of the country. In other words, the principal must remain intact and even be increased, and only the interest removed. New types of ecosystems better adapted to modern life and to provide for population growth may be substituted for the original types; this may correspond to an increased productivity (for instance, agriculture around Paris).

The course would include the usual natural sciences (botany, zoology, geology, physiology) besides pedology, climatology and general ecology. Knowledge of geography is essential since it introduces man both as a destroyer and a creator (human climax). The specific role of geography is to place human populations in the natural habitat (see examples cited above).

In this way, both economics and politics are concerned and human activity will be visible whether man be an occupier or a manager. When only protection of landscapes is mentioned, governments show no interest, but should they perceive an economical or pratical aspect, they request further information. An evaluation of the productivity of ecosystems holds their attention. Economical and even the social points of view should, however, not be neglected.

The curriculum, therefore, must include the social, economical and political aspects. The notion of law of the land should not be forgotten. Those responsible for the administration in the future must be aware of the serious problems related to conservation and protection of natural resources.

Appropriate teaching centres

The broad spectrum of projects leads to the consideration of a comprehensive curriculum which will necessarily be interdisciplinary and could therefore be taught in a single university but by several Faculties (Sciences, Arts and Letters, Law, etc.).

Conservation and protection of natural resources cannot be taught in every centre. Rather than arbitrary national units, it is proposed to set up regional centres encompassing broad climatic areas. A multiplication of universities for questions of prestige should be rejected (The Addis-Ababa Conference envisages the establishment of 35 new universities in tropical Africa by 1980). In view of the urgency of the problem and the serious economic situation, it is preferable to utilize to the

utmost the existing centres. At present, centres provided with sufficient collections of plants and animals are limited to the Universities of Dakar, Abidjan, and Nairobi, which also correspond to West Africa, both savannah and forest and to the dry regions of East Africa.

It may not be easy to adopt this point of view. But UNESCO is in a position and has the authority here to play a very important role. The argument relative to climate and the idea of extended ecosystems should be the determining factors for a study of the problem. This will also include a survey of the flora and fauna which are essential. The above-mentioned centres are already in possession of much of this information.

The conditions under which such a curriculum can be taught

The lack of qualified teachers is obvious and it will be therefore necessary to utilize to the best those already there. The possibility of moving around teachers but not students must also be examined. However, many specialists of tropical regions have now gone back to temperate countries, and it will be necessary, in order to benefit by their experience, to use them as itinerant teachers who would spend several months overseas.

The entire organization should be under the responsability of UNESCO, who would finance it. Student fellowships might be attributed to students from the countries constituting the climatic zones in which is situated the university.

Instead of establishing extra-university centres, UNESCO might sponsor foundations within the universities already existing, as for instance the Centre for Ecology and Photosynthesis sponsored by the Carnegie Foundation at Standford University. To such a teaching centre should be added a research centre, since it would be essential that the teachers also do research.

UNESCO should be called upon to promote a meeting of qualified persons who would prepare a list of eventual teachers and also non-teaching specialists who might be able to assure the teaching of such courses (1).

The impetus has been put on Africa, but the working group is fully aware that identical problems needing similar solutions also occur on other continents.

b) Primary school level.

Training of teachers for primary schools is also a problem. Teachers college have been established through the initiative of UNESCO in several African states. It might be possible for the future primary

(1) In the international field (FAO, IUCN) training of technical personnel for national parks is already under way. Two such centres exist : the one, in English, at M'weka (Tanganyika), and one in French at Yaoundé (Cameroon). Exchanges of students has also been envisaged.

school teachers, as well as for those of the lower secondary school level, to follow the courses on conservation of natural resources in the universities.

In order to meet the most urgent needs, handbooks prepared for primary school teachers should be published containing simple but obviously striking examples. Several of this kind have already been edited. Such handbooks contain typical examples — such as the effects of erosion — easily understood by children, who learn rapidly what must be done and what should not be done. Accompanied by fixed-films in lieu of illustrations, such examples remain « engraved on the eyes ».

Among texts published at the initiative of UNESCO can be cited : The Earth is our Capital (Asia Minor). Our Mother Nature (Sudan-Sahel).

It would appear that for Africa the handbook should include in its title the idea of science, in order to be better adapted. The course should also be included in General Knowledge, rather than in civic education. The handbooks and teachers should be used within the framework of a basic popular education adapted to the particular structure of each country.

Conclusions

This report represents a basis for a beginning which UNESCO is requested to examine in view of its implementation as efficiently and rapidly as possible. A commission of experts should be convened in order to define concrete measures that can be applied immediately at the different levels examined in this report and without waiting for the establishment of the new universities and research centres proposed by the Conferences of Addis Ababa and Lagos.

VIII. – CLOSING SESSION

During the final session of the Congress, Professor M.H. STONE summarised the work achieved and expressed his satisfaction with it.

Professor E.V. EMOVON thanked him in the name of the developing countries, and reminded the Congress of the considerable effort made by a number of countries to advance science education. He hoped a future conference would be arranged to follow up the study of science teaching at the elementary stage (a hope endorsed by Professor D. SETTE) as well as the study of the appropriation of supplies.

Mr. H. TABA and Professor W.J. JACOBSON desired to see developed in the secondary schools, the former the teaching of Meteorology, the latter the teaching of Earth Sciences, in which participation of the Union of Geophysics in the work of the CIES would prove helpful.

Professor B. THWAITES expressed a wish that the work of the Commission might become better known — towards which the publications of the Congress might contribute.

MM. M.H. STONE and P. FLEURY offered their heartfelt thanks to the Professors, the Secretariat, and the personnel of the Dakar Faculty of Science for their valuable help and their most cordial welcome, and to the Session Chairmen, the voluntary interpreters (in particular MM. P. LORRAIN, M. MINNAERT and E. SCHATZMANJ, and the participants for their attendance and numerous contributions.

In turn, a hearty vote of thanks was accorded to the organizers, to the Secretariate, and very particularly to President M.H. STONE for the arrangement and the very successful outcome of the Congress.

APPENDIX 1

LIST OF PARTICIPANTS

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Secretary : Mme A. VUKMIROVIC (3, bd Pasteur, Paris 15e, France).

APPENDIX 2

LIST OF THE REPORTS OF THE REPRESENTATIVES OF THE VARIOUS UNIONS

1. — Prof. M. Minnaert (Utrecht) : On modernizations in the teaching of *astronomy*. (10 p.), Juin 1964.

2. — Prof. P. Chouard (Paris) : Pour une mise à jour de l'enseignement de la *biologie*. (10 p.), Octobre 1964.

3. — Prof. G.M. Schwab (Munich) : Teaching of *chemistry* and economic development. (9 p.), Juillet 1964.

4. — Prof. A.J. Freuh (Montreal) : The role of *crystallography* in scientific teaching and economic development. (5 p.), Juin 1964.

5. — Prof. R. Clozier (Paris) : Révision à envisager pour l'enseignement de la *géographie* dans ses rapports avec les autres sciences. L'enseignement préuniversitaire de la géographie en Afrique, les écoles normales supérieures. (8 p.), Septembre 1964.

6. — Prof. T.N. George (Glagow) : The interdisciplinary relations of *geology*. (16 p.), Juin 1964.

7. — Prof. R. Taton (Paris) : L'enseignement de l'*histoire et de la philosophie des sciences* (9 p.), Novembre 1964.

8. — Prof. Y. Akizuki (Tokyo) : *Mathematical* education for other sciences. (20 p.), Septembre 1964.

9. — Prof. G. Temple (Oxford, G.-B.) : The teaching of *mechanics*. (1 p.), Mars 1964.

10. — Prof. S.C. Brown (Combridge, Mass.) : Recent trends in *physics* education. (10 p.), Juin 1964.

APPENDI 3

LIST OF THE REPORTS PREPARED FOR THE WORKING GROUPS

A. — Prof. R. Heller (Paris) : L'enseignement de mathématiques, de la physique et de la chimie à l'usage des biologistes. (23 p.), Novembre 1964.

B. — Prof. T.N. George (Glasgow) : Mathematics in the training of geologists. (10 p.), Janvier 1965.

C. — Prof. Ch. Pisot (Paris) : L'enseignement des mathématiques pour les physiciens (4 p.), Novembre 1964.

D. — Prof. H.F. Fehr (New York) : Mathematics education for scientific, technological and industrial needs of Society. (24 p.), Octobre 1964.

E. — Prof. M.Y. Bernard (Paris) : La formation des techniciens.(10 p.), Novembre 1964.

F. — Prof. J.G. Baer (Neufchâtel) : Conservation and exploitation of natural resources : teaching and organisation of specialised institutes, and problems peculiar to African countries. (9 p.), Novembre 1964.

INTERUNION COMMISSION FOR SCIENCE TEACHING

APPENDIX 4

Structure and activity of the CIES

The commission was created by the International Council of Scientific Unions in September 1964, when eight unions became members. Two other unions followed, as shown in the table below, which also gives the dates of the four meeting of the CIES and a list of participants and observers.

The Commission elected Professor M.H. Stone (1) (Mathematics) of Chicago as President, and Professor P. Fleury (Physics) of Paris, a co-opted member, as Secretary. Many national *corresponding members* have agreed to ensure the diffusion of the documents of the CIES and to transmit to it all informations that they are able to gather on the state and on the advancement of Science Teaching in their countries (See page 53).

An effective collaboration has been established with the United Nations Educational, Scientific et Cultural Organization (UNESCO) (Department of exact and natural sciences and Department of Education). Contacts have been made with other international and multinational organizations interested in science teaching, namely :

World Confederation of school-teaching organizations; International Association of University Professors; International Association of Atomic Energy; Organization of American States (OAS); Organization for Cooperation and Economic Development (OCED).

The Commission has dealt with such problems of general concern as :

role of science teaching in general education;
enrolment, situation and training of teachers;
equivalence of teaching levels and curricula in different countries;
role of the history of science in science teaching;
necessity of publishing textbooks linking the several sciences;
need for attempt to centralizing all documents on new pedagogical methods, revision of programs, etc.

Until these ends can be achieved (which would require substantial funds); the Secretariate of the CIES circulates information received from the Teaching Committees of various Unions and information on

(1) Professor Stone having resigned in April 1965, the CIES Presidency is now assumed by Professor T.N. George, of Glasgow.

PARTICIPANTS ON CIES MEETINGS

REPRESENTATION OF THE UNIONS (1)	MAY 1962 (Paris)	SEPTEMBER 1963 (Frascati)	MAY 1964 (Paris)	JANUARY 1965 (Dakar)
(A) Astronomy (1964)	—	—	—	E. SCHATZMANN
(B) Biology (1961)	P. CHOUARD	J. B. S. HALDANE	P. CHOUARD	P. CHOUARD
(Ch) Chemistry (1961)	E. L. PIRET	G. M. SCHWAB	—	G. M. SCHWAB
(Cr) Cristallography (1964) ...		—	A. J. FRUEH	A. J. FRUEH
(Gr) Géography (1961)	P. PELISSIER	R. CLOZIER	R. CLOZIER	R. CLOZIER
(Gl) Geology (1961)	T. N. GEORGE	T. N. GEORGE	T. N. GEORGE	T. N. GEORGE
(H) History and philosophy of Sciences (1961)	R. TATON	R. TATON	R. TATON	R. TATON
(Ma) Mathematics (1961)	M. H. STONE	M. H. STONE	M. H. STONE	M. H. STONE
(Me) Mechanics (1961)	—	G. TEMPLE	G. TEMPLE	B. THWAITES
(P) Physics (1961)	S. C. BROWN P. FLEURY	D. SETTE P. FLEURY	S. C. BROWN P. FLEURY	D. SETTE P. FLEURY
Observers of the Unions	M. BOURREAU (B.) P. BELLAIR (Gl)	M. MINNAERT (A.) M. CRAWFORD (Ch.) H. CURIEN (Cr) A. J. FRUEH (Cr)	H. CURIEN (Cr) A. LICHNEROWICZ (Ma) L. SCHWARTZ (Ma)	M. MINNAERT (A) R. HELLER (B.) J. BAER (B) M. FERNIG, M. WALTER S. BUNDGAARD (Ma) H. FEHR (Ma) Ch. PISOT (Ma)
UNESCO	A. BAEZ	M. WROBLEWSKI	Mme A. HUNWALD A. LICHNEROWICZ (Ma) Mlle A. LITSCHAUER	Mme A. HUNDWALD P. BANDYOPADHYAY
OCED	R. E. GANEFF			
FORD Foundation	M. TRAUTMAN	M. NORTHROP		

(1) The dates in brackets refer to the adhesion.

outstanding books, papers, activities, and achievements of which he is aware.

One of the most urgent problems, concerning the co-ordination of the teaching of mathematics with teaching of other sciences, formed the subject of important exchanges of viewpoints at the Frascati conference organised by the Commission in September 1963, with the aid of a liberal grant from the Ford Foundation and of the hospitality of the Italian Ministry of Education. Thirty-two experts attended this conference, with Professor M.H. STONE in the Chair.

On the proposals of the Frascati conference, the program of the First International Congress on Science Teaching, suggested as early as 1962 was devised in detail during the meetings of 1964 and 1965.

During the latter it has been decided that for the coming months, all efforts should be concentrated on the following points :

a) Final redaction and publication of the documents prepared by and for the Dakar Congress;

b) Preparation of a « Selected Collection of examples of applications of mathematics to various other sciences;

c) Comprehensive study of the conditions for *science education in the training of teachers* for junior and elementary schools as well as secondary and technical teaching;

d) Comprehensive study of the *distribution of teaching time* among the various branches of instruction.

Under items (c) and (d), the Commission proposes to conduct a preliminary enquiry through the Teaching Committees of various Unions and the interdisciplinary national Commissions.

The very important problem of the training of technicians is also exercising the attention of the Commission, which proposes to collaborate with a number of other organizations already studying the problem from various viewpoints.

It is hoped that the meeting of a Second Congress — whose program will be prepared (in collaboration with such other bodies as may be able to furnish funds) at the next meeting of the CIES — will be held in 1967 or 1968.

The presently elected members of the CIES are as follows :

Union of	Regular members	Substitute members
Astronomy	Prof. E. SCHATZMAN, 98 bis, bd Arago, Paris 14e, France.	
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Dépôt légal : 307 - 1965